Diurnal asymmetry of surface temperature trends over India

K. RupaKumar, K. Krishna Kumar and G.B.Pant, 1994

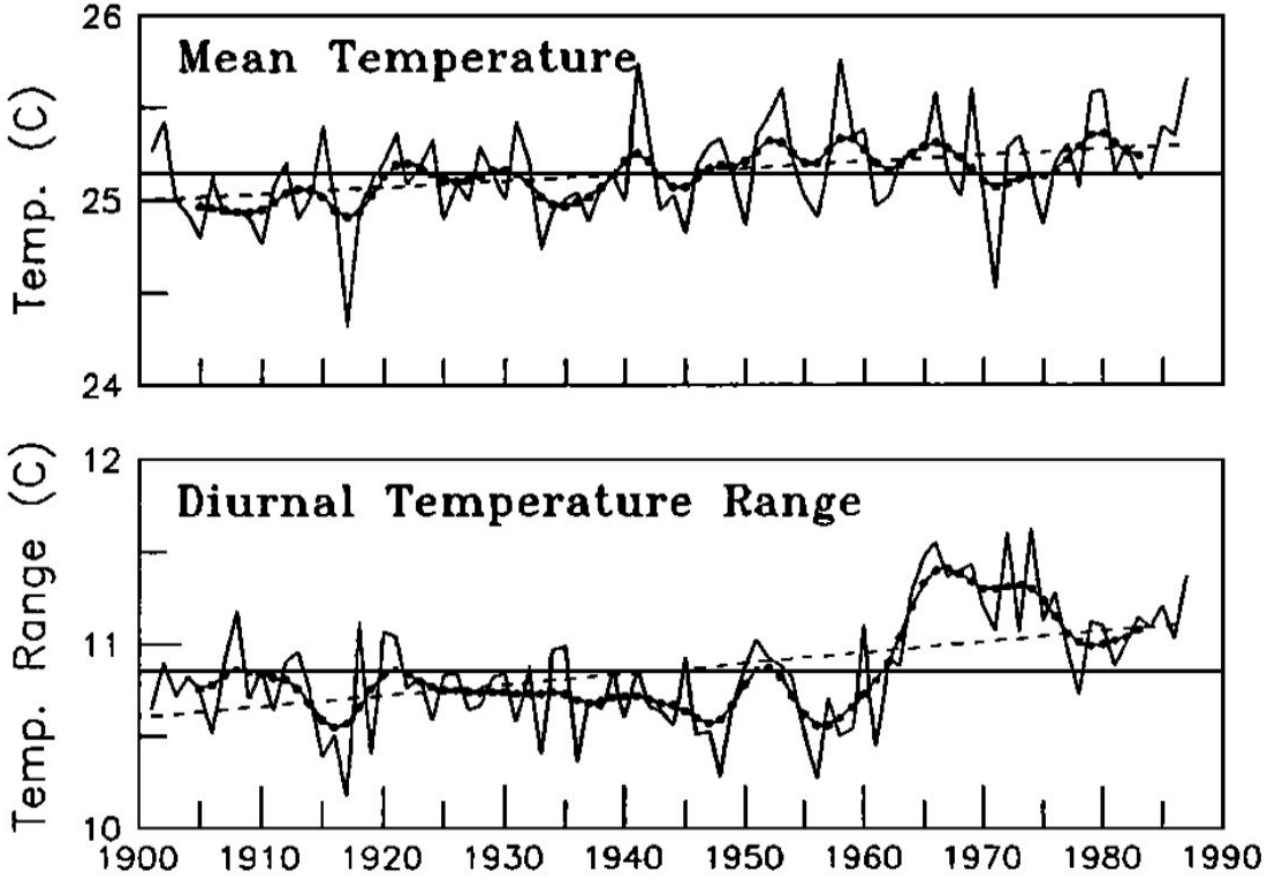
Background

- Need focus on day & night-time temperatures since they linked to humidity, circulation patterns and cloudiness, instead of just mean temperatures
- IPCC stressed on reinterpreting land record regionally in terms of max-min temperatures
- This paper analysed max and min temperatures separately to isolate diurnal asymmetry

Data Analysis

- Monthly max-min temperatures from 121 stations from 1901-1987
- Stations arranged in 4 groups for trend analysis: All India, Urban/Non-Urban, Low/High Altitude, 6 Homogenous regions
- Mean series for each group computed for whole year as well as 4 seasons

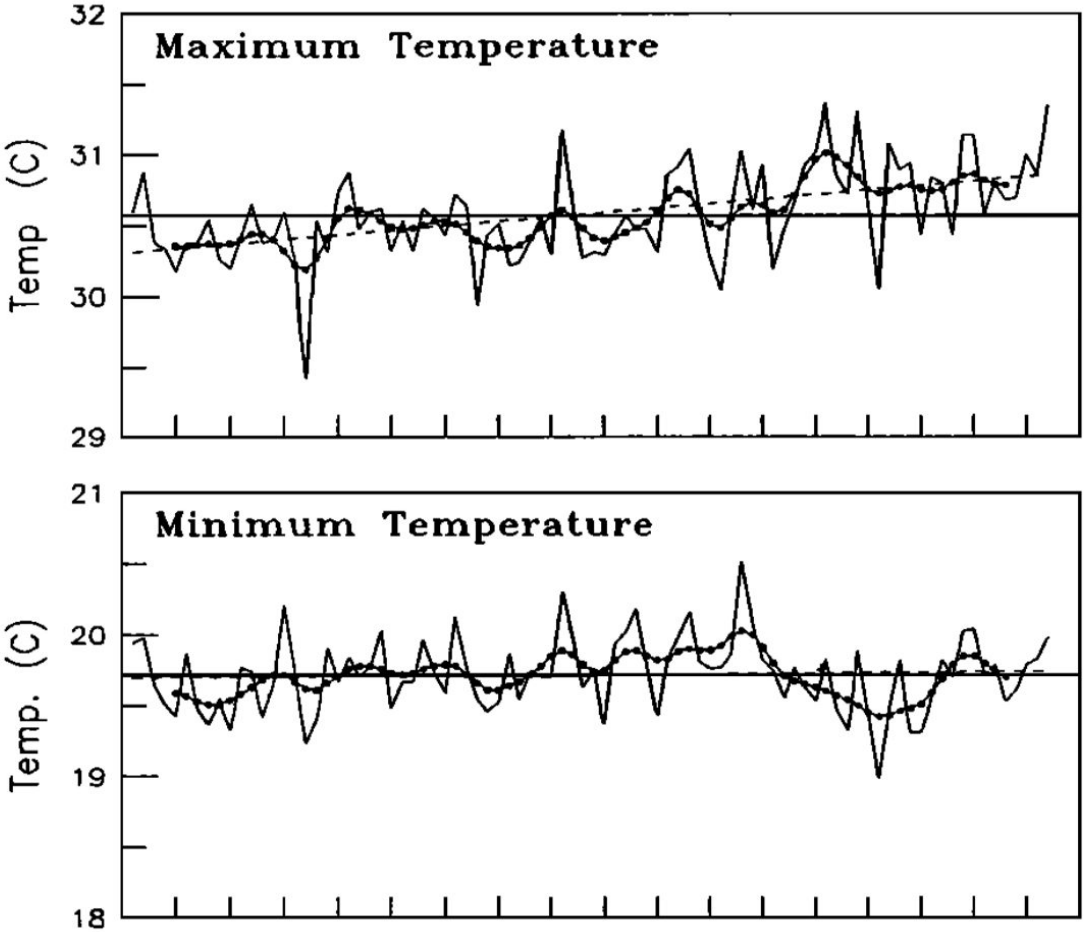
Results



0.6°C/100 yr increase in mean temperature

Due to rise in max temp and small change in min temp, the range increases

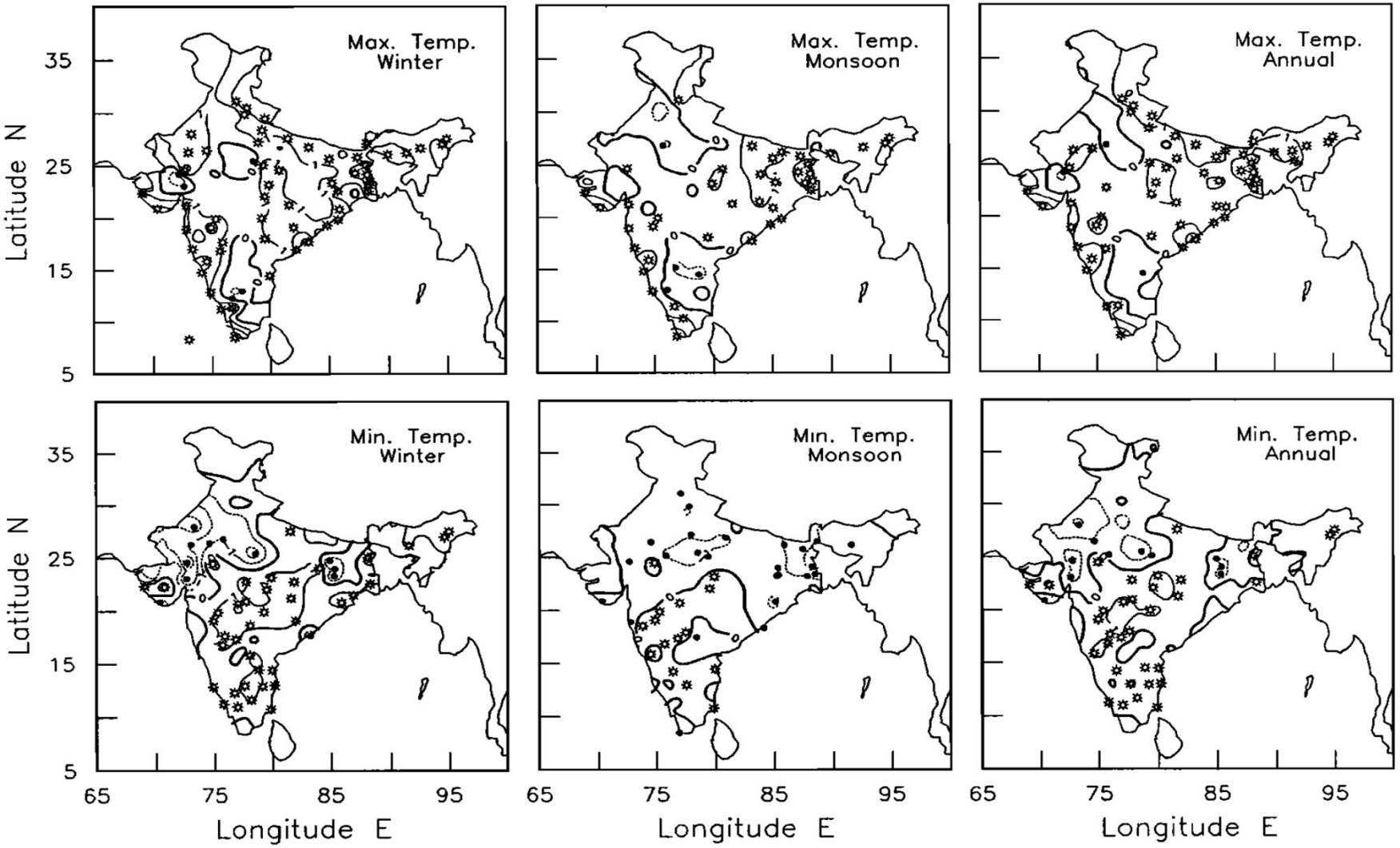
Results


Maximum Temperature
Temp (C)
32
31
30
29
Minimum Temperature
Temp. (C)
21
20
19
18

Results

- Rise in max temp is high and significant in all seasons except the monsoon, while no significant trend for min temp in any season
- No significant difference in urban/non-urban and low/high altitude stations

Spatial Patterns


Max. Temp.
Winter
Max. Temp.
Monsoon
Max. Temp.
Annual
Min. Temp.
Winter
Min. Temp.
Monsoon
Min. Temp.
Annual
Latitude N
35
25
15
5
65
75
85
95
Longitude E

Key Insights

- Maximum temperatures increasing over most parts of India, while minimum temperatures don’t rise much
- Leads to increase in diurnal temperature range
- Increase in mean temperatures over India mostly contributed by the maximum temperatures and not the minimums
- Diurnal asymmetry in India different from others

On the recent changes in surface temperature trends over India

D. R. Kothawale and K. Rupa Kumar, 2005

Data Analysis

- Monthly temperature data from 121 stations for 1901-2003
- Temperature series made across 7 homogenous regions and 4 seasons
- Due to limited data climatological normals of monthly mean max-min for 1951 – 80 for 388 well-spread stations were taken for more a more realistic approach

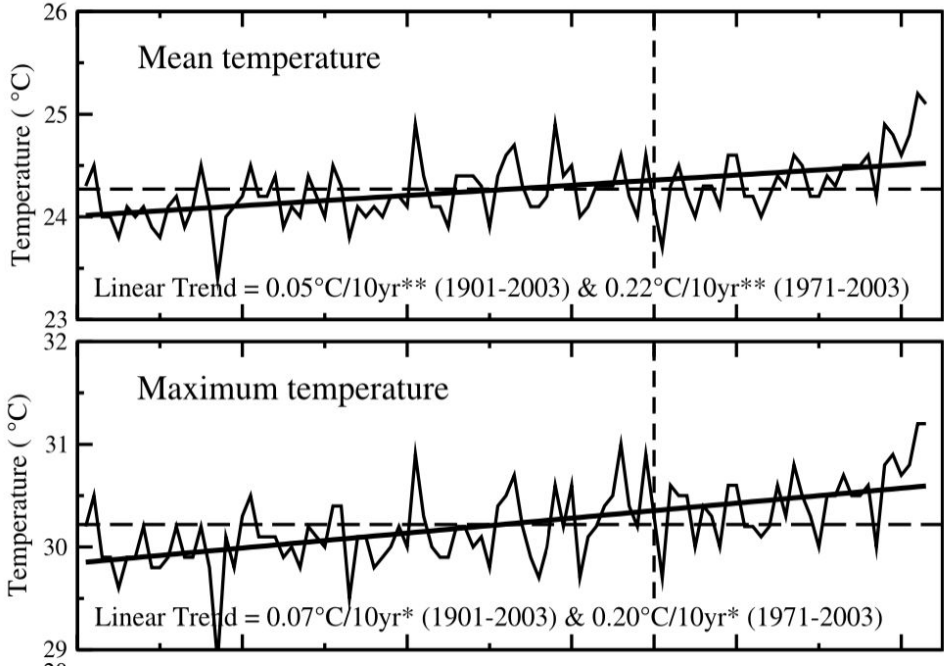
Data Analysis

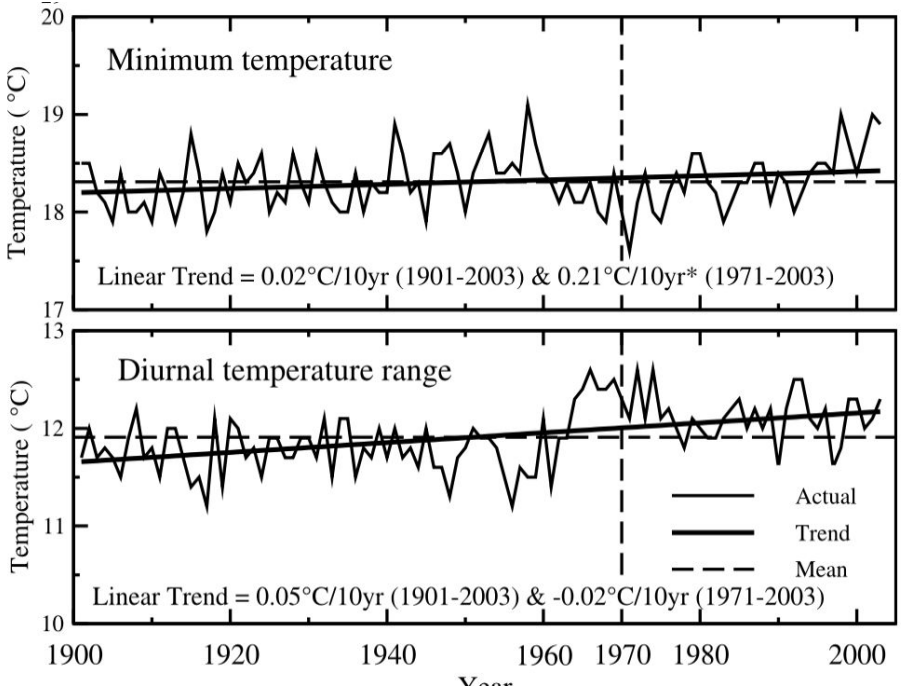
- For spatially representative temperature means for the homogenous regions the following procedure was used:
- Data from 121 stations converted to monthly anomaly time series for 1901-2003 w.r.t station normal values
- This was interpolated onto 0.5°x0.5° grid
- Then the climatological normals were also interpolated onto the same grid

Data Analysis

- This gave high-resolution grid point temperature climatology
- Finally, gridded monthly anomaly values were added to the gridded climatology based on 388 stations, giving a long-term gridded data set of actual temperatures for 1901–2003.
- Simple averages of the grid points taken for respective regions

Results


Mean temperature
Temperature (°C)
Linear Trend = 0.05°C/10yr** (1901-2003) & 0.22°C/10yr** (1971-2003)
Maximum temperature
Temperature (°C)
Linear Trend = 0.07°C/10yr* (1901-2003) & 0.20°C/10yr* (1971-2003)


Minimum temperature
Temperature (°C)
Linear Trend = 0.02°C/10yr (1901-2003) & 0.21°C/10yr* (1971-2003)
Diurnal temperature range
Temperature (°C)
Actual
Trend
Mean
Linear Trend = 0.05°C/10yr (1901-2003) & -0.02°C/10yr (1971-2003)
1900
1920
1940
1960
1970
1980
2000

Results

- For 1971-2003, the rise in mean temperatures is contributed to by both the max and min temperatures
- 1971-2003 also sees stagnation in diurnal temperature range due to min temperature also rising
- For seasonal trends, max temp is warming in all seasons for 1901-2003, but for 1971-2003 only winter and pre-monsoon showed significant warming

Results

- Area under significant warming in terms of **max** temp shows reduction from 1901-2003 to 1971-2003 in all seasons
- Area under significant warming in terms of **min** temp for All India has no significant trend for 1901-2003, but is significant for winter and post monsoon

Results

- For spatial trends, min temp has shown greater area under the warming trends than the max temp during 1901-2003, which also shows some cooling trends in the monsoon season
- But for 1971-2003, area under cooling trends virtually disappears across seasons and monsoon shows the greatest area under warming trends

Results

- Total area under warming in terms of max temperature has reduced during recent periods, it has increased in terms of min temperature.

	Warming Trend Area (%)			
	Max. Temp.		Min. Temp.	
Season	1901–2003	1971–2003	1901–2003	1971–2003
DJF	70	39	44	37
MAM	38	9	24	22
JJAS	43	20	16	48
ON	59	28	53	17
Annual	63	31	34	36

Cooling Trend Area (%)			
Max. Temp.		Min. Temp.	
1901–2003	1971–2003	1901–2003	1971–2003
0	1	7	0
0	0	8	0
2	0	17	1
0	0	3	0
0	0	7	0

Key Insights

- Diurnal asymmetry has turned in recent years since increase in min temperature also contributes to the warming trends, especially during monsoon
- Temperature anomalies associated with large- scale monsoon anomalies may persist through the following dry season.
- Area under warming w.r.t max temp has reduced for 1971-2003 compared to the whole period

Key Insights

- Diurnal asymmetry has turned in recent years since increase in min temperature also contributes to the warming trends, especially during monsoon
- Temperature anomalies associated with large- scale monsoon anomalies may persist through the following dry season.
- Area under warming w.r.t max temp has reduced for 1971-2003 compared to the whole period

Key Insights

- India could be coming under a more global regime of increasing night-time temperatures that other studies have explored before

Temperature Prediction using Machine Learning Approaches

Anjali T, Chandini K, Anoop K, Lajish V L, 2019

Overview

- Machine learning based method for temperature prediction in Central Kerala
- Comparative analysis of MLR, SVM and ANN
- Humidity, pressure, wind speed, wind direction selected as parameters

Methods

- **MLR:** Temperature = 368.4949 + 0.1639*humidity + 0.3254*pressure + 0.0027*wind direction + 0.0098 * wind speed
- **ANN:** FNN
- **SVM:** SVR with radial basis function kernel

Data and experiment

- Data collected from 3 Central Kerala districts
- 43815 weather instances with 5 fold cross-validation
- ME, MAE, RMSE and Correlation Coefficient used for evaluation

Results

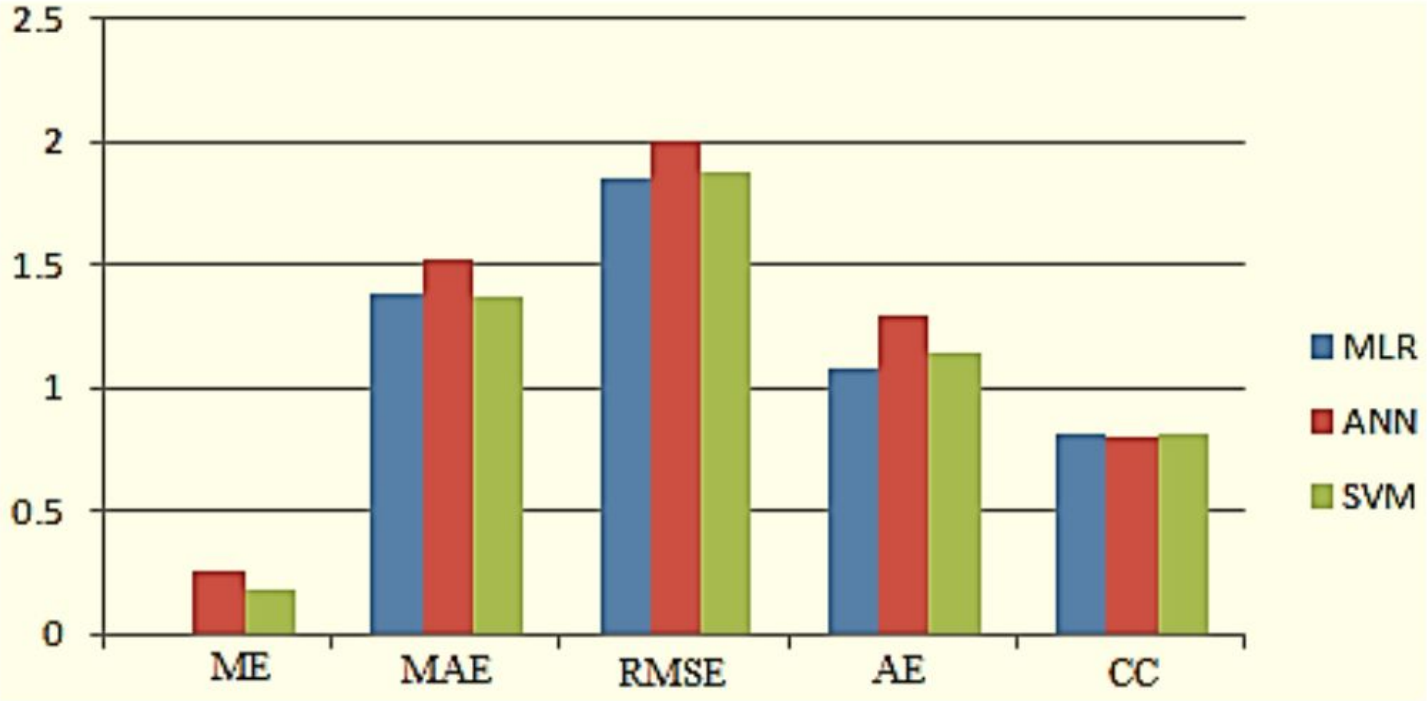


Fig. 2. Comparison of prediction accuracies of MLR, ANN and SVM

Results

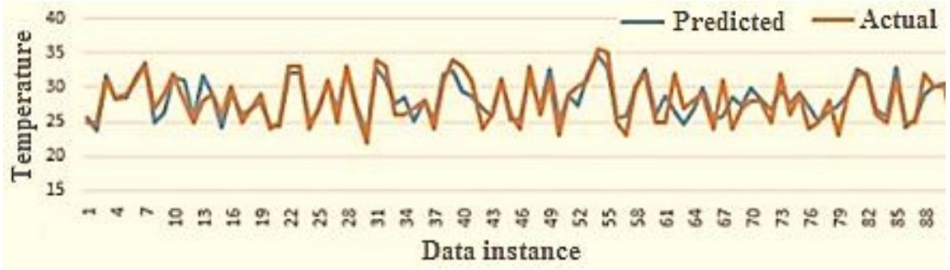


Fig. 3. Actual temperature verses the predicted temperature using MLR

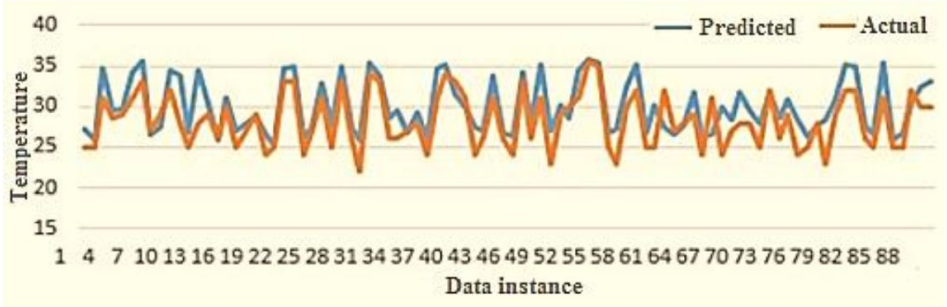


Fig. 4. Actual temperature verses the predicted temperature using ANN

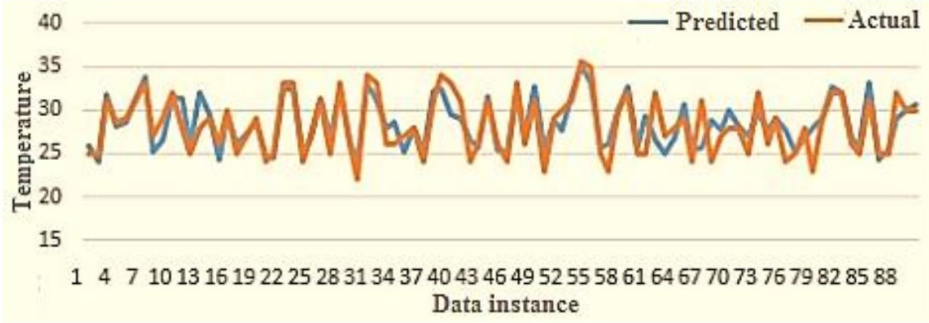


Fig. 5. Actual temperature verses the predicted temperature using SVM

Insights

- MLR performed best here
- But no time lag mentioned in the paper, hence not predicting the temperature in the future
- Similar method could possibly be used to find out which parameters affect future temperature the most